

ESRL RAP/HRRR updates - Jan-Apr 2013

Effective concluding with the 23 UTC 06 April 2013 cycle the ESRL/GSD RAP and HRRR have been upgraded to include the following data assimilation and model changes:

ESRL RAP 13-km Data Assimilation Changes (in chronological order):

(1) Updated Gridpoint Statistical Interpolation (GSI) package to a recent trunk revision (**change effective 08 UTC 15 January 2013**).

- Important for consistency with trunk code
- Change in forecast quality - **small**

(2) Modified the precipitation analysis to properly specify snow from observed radar reflectivities and background snow in full model columns under cold surface conditions (< 5C) and specify rain and/or snow at the level of maximum observed radar reflectivity under warmer surface conditions (> 5C). Rain and snow is removed (cleared) from the model at all locations where the radar observations indicate no precipitation when over the warmer surface (**changes effective 06 UTC 29 January 2013**).

- Change in forecast quality - **medium** especially for winter season

(3) Enabled GSI hybrid data assimilation with model background error covariances now including a flow (weather) dependence derived from a GFS 80-member ensemble forecast at 60-km using the Ensemble Kalman Filter in combination with a static 3-D model background error covariance to improve the assimilation of all observations. A slightly tighter fit to upper-level observations at the analysis time and throughout the forecast period can be expected (**change effective 06 UTC 27 March 2013**).

- Change in forecast quality - **high** for all applications and seasons

(4) Snow and rain hydrometeors, now including snow and rain mixing ratios and rain number concentration, retrieved from radar reflectivity observations using the Thompson microphysical relationship allow for a reversible model reflectivity diagnostic (**change effective 06 UTC 27 March 2013**).

- Post-processing change - important for output reflectivity fields

(5) Changed the soil temperature and moisture adjustments, based upon lowest level temperature and dew point innovations, to be symmetric with respect to both warming/drying and cooling/moistening the soil conditions. The magnitude of the adjustments has also been increased (**changes effective 06 UTC 27 March 2013**).

- Change in forecast quality - **medium** overall, more in warm season, minimizes soil moisture biases

(6) Modified the influence of surface (METAR) ceiling observations under conditions of nearby fractional cloud cover in the background field to reflect observed ceiling at, at least, both the nearest model grid point and the surrounding four grid points but allow retention of nearby partial cloud cover. (**change effective 06 UTC 27 March 2013**).

- Change in forecast quality - **small** but improves initial cloud (3-d hydrometeor) fields

(7) Changed the cycled snow cover fields in the RAP through modifications in building and/or removal of snow cover in the 00 UTC cycle based upon the Interactive Multisensor Snow and Ice Mapping System (IMS) snow cover analysis. Surface temperature dependence has been removed from the snow trimming analysis. Snow building capability is enabled when surface temperature T < 278 K. (**change effective 17**

UTC 13 March 2013).

- Change in forecast quality - **medium** for 2m temperature, corrects large local surface temperature errors from erroneous snow cover, especially in spring and late winter (**small** overall)

ESRL RAP 13-km Model Changes (in chronological order):

(1) Increased the surface roughness length values for forests, cropland and urban land-use categories to help reduce the high wind speed bias near the surface. Added seasonal variations to leaf area index and cropland roughness length. Implemented exponential formulation to define effective roughness length in the grid cell from contributions of all land use categories in the grid cell. Other surface characteristics are defined from weighted average formulation.**(changes effective 07 UTC 09 March 2013).**

- Change in forecast quality - **medium** for near-surface wind forecasts, **small** overall

(2) Added a correction to the Goddard shortwave radiation scheme to allow for attenuation through snow and reduce excessive warming of the surface conditions during the daytime in regions of snow precipitation
(change effective 07 UTC 09 March 2013).

- Change in forecast quality - **small** overall (but corrects warm bias and even precipitation type error in certain situations)

(3) Increased the number of soil levels/layers in the RUC-based land surface model from six to nine between the surface and 3 m below ground level for more accurate ground and surface sensible and latent heat fluxes
(change effective 15 UTC 13 March 2013).

- Change in forecast quality - **small** overall but improves diurnal cycle of temperature and boundary layer behavior in forecasts

(4) Updated Advanced Weather and Research Forecast model (WRF-ARW) from a version 3.3.1 code base to a version 3.4.1 code base including an updated Thompson microphysics version **(changes effective 06 UTC 27 March 2013).**

- Important for consistency with community code
- Change in forecast quality - **small** overall

(5) Adjusted the model radar reflectivity diagnostic to maintain consistency with the latest Thompson microphysics scheme and ensure reversibility with the retrieval of rain and snow hydrometeors from radar reflectivity observations **(changes effective 06 UTC 27 March 2013).**

- Post-processing change - important for output reflectivity fields

(6) Changed the surface and boundary layer parameterization scheme to MYNN (Mellor-Yamada-Nakanishi-Niino) from MYJ (Mellor-Yamada-Janjic) including additional modifications to the MYNN boundary layer parameterization for decreased diffusivity and improved low-level wind and temperature forecasts with a reduced diurnal temperature bias **(change effective 23 UTC 03 April 2013).**

- Change in forecast quality - **medium-high** overall especially in lower-tropospheric wind forecasts

HRRR 3-km Data Assimilation Changes (in chronological order):

(1) Introduced direct 3-km data assimilation using a 01-hr old 13-km ESRL RAP post-DFI (digital filter initialization) analysis as a first guess, followed by assimilation of radar reflectivity-derived latent heating at 15min intervals through a 1-hour period before applying a complete GSI 3D-varitional analysis using most observations at 3 km and then apply a non-variational cloud and precipitation hydrometeor analysis. This

change will produce a very noticeable increase in smaller storm-scale structures in the HRRR 00-hr analysis and transition through the first several forecast hours (**changes effective 23 UTC 06 April 2013**).

- Change in forecast quality - **high** for convective storm and precipitation forecasts in first 3-4h, **medium** otherwise

HRRR 3-km Model Changes (in chronological order):

(1) Increased the surface roughness length values for forests, cropland and urban land-use categories to help reduce the high wind speed bias near the surface. Added seasonal variations to leaf area index and cropland roughness length. Implemented exponential formulation to define effective roughness length in the grid cell from contributions of all land use categories in the grid cell. Other surface characteristics are defined from weighted average formulation. (**changes effective 07 UTC 09 March 2013**).

- Change in forecast quality - **medium** for near-surface wind forecasts (for areas with forest, cropland, urban land-use categories), **small** overall

(2) Increased the number of soil levels/layers in the RUC-based land surface model from six to nine between the surface and 3 m below ground level for more accurate ground and surface sensible and latent heat fluxes (**change effective 21 UTC 13 March 2013**).

- Change in forecast quality - **small** overall (but corrects warm bias and even precipitation type error in certain situations)

(3) Updated Advanced Weather and Research Forecast model (WRF-ARW) from a version 3.3.1 code base to a version 3.4.1 code base including an updated Thompson microphysics version (**changes effective 19 UTC 30 March 2013**).

- Important for consistency with community code
- Change in forecast quality - **small** overall

(4) Changed from Dudhia to Goddard shortwave radiation scheme including the correction for attenuation through snow and is now consistent with the use of a model pressure top above 50 hPa (**change effective 19 UTC 30 March 2013**).

- Change in forecast quality - **small** overall (but corrects warm bias and even precipitation type error in certain situations)

(5) Adjusted the model radar reflectivity diagnostic to maintain consistency with the latest Thompson microphysics scheme and ensure reversibility with the retrieval of rain and snow hydrometeors from radar reflectivity observations (**change effective 19 UTC 30 March 2013**).

- Post-processing change - important for output reflectivity fields

(6) Changed the surface and boundary layer parameterization scheme to MYNN (Mellor-Yamada-Nakanishi-Niino) from MYJ (Mellor-Yamada-Janjic) including additional modifications to the MYNN boundary layer parameterization for decreased diffusivity and improved low-level wind and temperature forecasts with a reduced diurnal temperature bias (**change effective 01 UTC 04 April 2013**).

- Change in forecast quality - **medium-high** overall especially in lower-tropospheric wind forecasts

(7) Enhanced the HRRR post-processing (**change effective 19 UTC 30 March 2013**), and along with the 3-km data assimilation configuration change (**change effective 23 UTC 06 April 2013**), reduced the *latency of HRRR forecasts by between 30 and 45 min*. HRRR model forecasts for a given hourly run will now commence at about 01 hr after the wall clock time and complete, including all post-processed grids, by just

after 02 hrs after the wall clock time.

- Change in forecast quality - none. A 30-45 min decrease in latency is quite important for HRRR forecast users.

The ESRL RAP and HRRR data assimilation and model configurations will now remain “frozen”, with the exception of software bug fixes, through the remainder of the spring, summer and early fall with the next changes being applied on or after 01 November 2013.